NZ02 Development of Virtual Patients for Mechanical Ventilation

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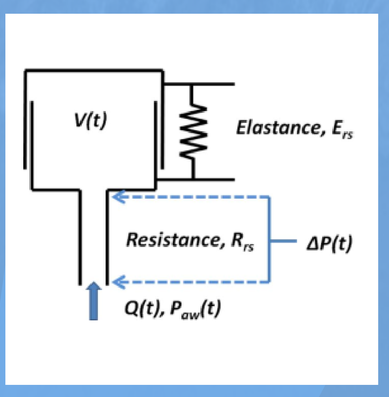
Mechanical ventilation is a key therapy for critically ill patients who cannot breathe

Problem: Ventilator settings need to be personalised and predictive.

Solution: Create personalised (and real time) mathematical models to predict what effect changes in ventilation will have on the lungs.

- Titrating PEEP (an added pressure at the end of expiration) during a recruitment manoeuvre until minimum elastance is reached improves patient outcomes.
  - This can subject the lungs to high pressures, risking ventilator induced lung injury.
- **Accurate prediction in changes in ventilation treatment does not exist.**
- This developed basis function model based on a validated single compartment model will allow clinicians to **predict** the peak pressures reached in a breath, **maximising oxygenation and minimising risk**

Single Compartment Model



$$P(t) = EV(t) + RQ(t) + PEEP$$

Ventilation begins

Treatment A or Treatment B ?

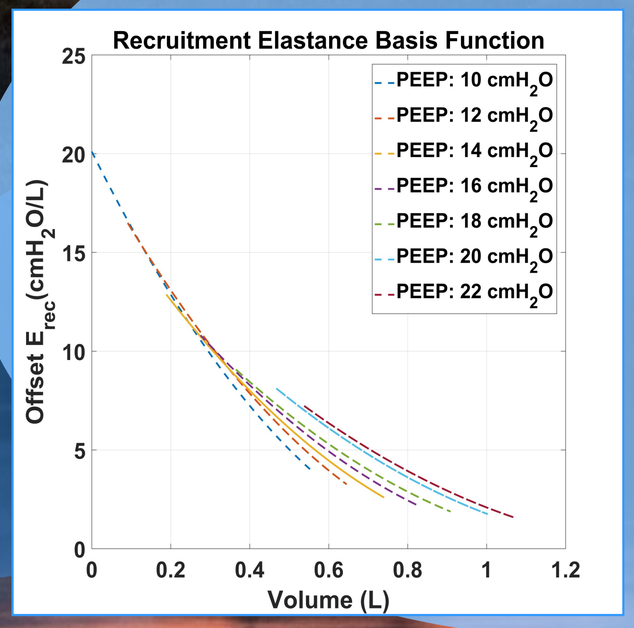
Use physiologically relevant elastance models to suggest treatment

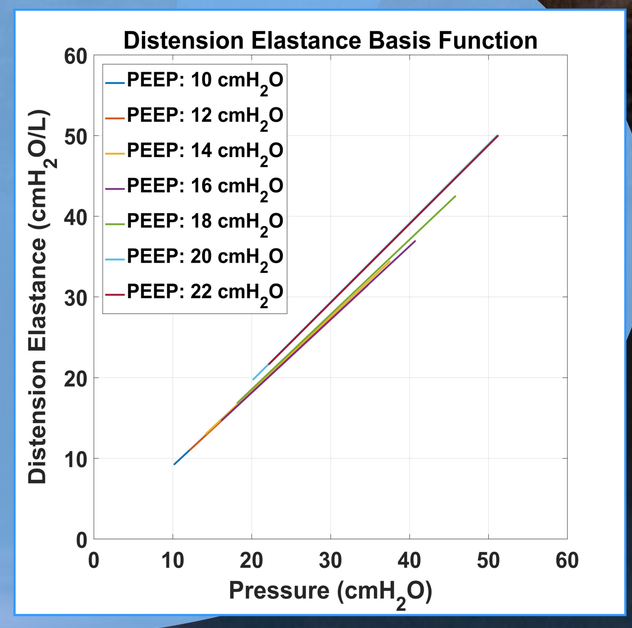
PREDICTION of outcome

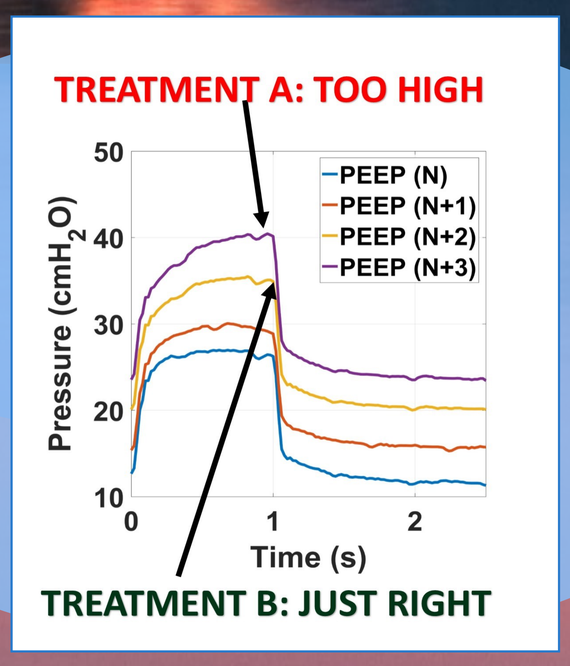
Treatment Choice:

Personalised Treatment and Improved Care

$$P(t) = \left(E_1\left((V + V_{frc}) - V_m\right)^2 + E_2\frac{P(t)}{60}\right)V(t) + (R_1 + R_2|Q(t)|)Q(t) + PEEP_{n+1}$$







- **Model tested on 2 diverse cohorts of ventilated patients.**
- **Overall error in predicting peak pressure of 2.9 [2.0 - 4.5] % (median [IQR]) in changes of up to 16 cmH_2O (an entire recruitment manoeuvre) offering highly accurate risk prediction prior to beginning treatment.**